in 1815, three generations being passed under review. Forty individuals are not recorded to have shown anti-social traits, but the remainder all failed in self-control, many being dishonest, and tending to alcoholism, or to profligacy, forty-one of these being "obviously a burden to society." These objectionable features were most pronounced in the case of offspring of a marriage of first cousins; Prof. Davenport's conclusion that violence of temper is a "dominant" character is confirmed, as in this family it was not found to "skip a generation." Most thoughtful readers of the bulletin will agree with the suggestion at the end of the preface that "unless society steps in and trains the trainable and segregates the uncontrollable, things will go from bad to worse."

Human endowments of a more pleasing kind are discussed by Dr. H. Drinkwater in a paper entitled "Inheritance of Artistic and Musical Ability," published in the last number of the *Journal of Genetics* (v., No. 4). He gives pedigrees—extending in some cases over four generations—of several families of artists and musicians, which indicate that where both parents are talented all the children inherit the talent, while a non-artistic or non-musical pair never have talented offspring. Hence he infers that artistic or musical ability is a recessive Mendelian character. When only one parent is musical, the number of children showing the recessive character may be more than the 50 per cent. required by the theory, but the records are too few for this to be regarded as a fatal difficulty to Dr. Drinkwater's interpretation. It will, however, be surprising if further research confirms the view that the complex nervous specialisation which must be supposed to accompany marked artistic or musical ability is determined by a simple genetic factor comparable with that which settles the colour of the eyes.

To the Journal of the Royal Statistical Society (vol. lxxix., part 2) Major Leonard Darwin contributes a paper on the inquiries needed after the war in connection with eugenics. He dwells on the selection of the best men generally for the fighting-line, shows that a higher death-rate may be expected to affect the more daring and self-sacrificing, and points out the meaning for the nation's future of the abnormally heavy losses among officers. His plea for a full investigation of the problem and of possible remedial measures may meet with a disappointing response, but nobody can read his paper and the report of the subsequent discussion—especially after studying the American bulletin summarised above—without realising the "reversed selective action" of the present world-conflict, and perceiving how absolutely opposed to the biological principles enunciated by Major Darwin's great father are those modern "people that delight in war."

G. H. C.

THE BRITISH ASSOCIATION AT NEWCASTLE.

SECTION C.

GEOLOGY.

Opening Address (Abridged) by Prof. W. S. Boulton, D.Sc., F.G.S., President of the Section.

If we attempt to compare the growth of applied geology in Britain with that, say, in the United States of America, or even in our great self-governing Dominions, or to appraise the knowledge of, and respect for, the facts and principles of geology as directly applicable to industry in these countries and in our own, or to compare the respective literatures on the subject, I think we shall have to confess that we have lagged far behind the position we ought by right of tradition and opportunities now to occupy. The vast natural resources of the countries I have named have doubtless stimulated a corresponding effort in their profitable development. But making due allowance for the fact that Britain is industrially mature as compared with these youthful communities, we cannot doubt that in this special branch of geology, however splendid our advances in others, we have been outstripped by our kinsmen abroad.

To attempt an explanation of this comparative failure to apply effectively the resources of geology to practical affairs would demand a critical analysis of the whole position of science in relation to industry and education which is being so vigorously debated by public men to-day. It is unquestionably due, in no small measure, to our ignorance and neglect of, and consequent indifference to, science in general, more especially on the part of our governing classes. This war, with all its material waste and mental anguish, may bring at least some compensation if it finally rouses us from complacence and teaches us to utilise more fully the highly trained and specialised intelligence of the nation.

Here I digress for a moment to lay stress upon a great and needless loss of valuable and detailed knowledge of our Coal Measure geology. It is well known that the Home Office Regulations demand that plans of workings in the different seams at a colliery shall be made and maintained by the colliery officials; and that on the abandonment of the mine copies of such plans shall be kept at the Mines Department of the Home Office for future reference. For ten years, however, they are regarded as confidential. Such information is recorded primarily with a view to the prevention of accidents due to inrushes of water and accumulations of gas.

Unfortunately, as mining men can testify, the plans are often woefully incomplete, inaccurate, and positively misleading as regards such features as faults, rolls, wash-outs, and so forth, and this is notoriously so along the margin of the plans where workings have been abandoned. Cases have been brought to my notice where plans of old workings have been consulted when adjacent ground was about to be explored, and afterwards the plans have proved to be grossly inaccurate, with the consequent risk of serious economic waste. I believe this unfortunate state of things is partly the effect of the complete official severance of the Geological Survey and the Mines Department of the Home Office. When the Geological Survey was first established, and for many years afterwards, a Mining Record Office for the collection and registration of all plans relating to mining operations was attached to it; but afterwards the Mining Record Office was transferred to the Home Office.

I would suggest that it ought to be made possible for all mining plans to be periodically inspected by Government officials with geological knowledge, not merely after the plans are deposited in a Government office, but during the working of the mine; so that, if desirable or necessary, the geological facts indicated by the mine-surveyor on the plan can be tested and verified. If accurate and properly attested plans of old workings were always available, the opening up of new ground would be greatly facilitated and much waste of time and money would be avoided.

Need for Systematic Survey by Deep Borings.

When we turn our attention to the possible extension of the Coal Measures under the newer strata of South-Central England, the geological data at our disposal are lamentably and surprisingly few. Notwithstanding our eagerness to unravel the difficulties, and so to open up new fields for mining activity, very little positive progress has been made in the last twenty years. Of late a few deep borings have been sunk; one near High Wycombe, after piercing the Mesozoic cover, ended in Ludlow rocks; another at Batsford, in Gloucestershire, fifteen miles north of the well-known Burford boring, struck what are regarded as Upper Coal Measures, also resting on Silurian rocks.

At the present time it seems specially fitting to direct attention once again to our haphazard method of grappling with this great economic question. Are we to go on indefinitely pursuing what is almost "wild-cat" boring, to use the petroleum miner's expressive slang? Or shall we boldly face the fact that systematic exploration is demanded; and that this pioneer work is a national obligation, the expense of which should be a national charge?

At a meeting of the Organising Committee of Section C a recommendation was forwarded to the council in the following terms:—

"The council of the British Association for the Advancement of Science recommends that the site, depth, and diameter of every borehole in the British Isles exceeding 500 ft. in depth be compulsorily notified and registered in a Government office. That all such boreholes be open to Government inspection during their progress. That copies of the journals and other information relating to the strata penetrated by the boring be filed in a Government office under the same restrictions as those relating to plans of abandoned mines."

I would go further and urge that the Government should undertake the sinking of deep borings at selected points. This is no new idea. In his presidential address to the Geological Society of London in 1912 Prof. Watts pleaded most forcibly the vital importance of a State-aided underground survey of the area to which I have referred. The work is too vast for individual effort, or even for a private company to undertake. It is not suggested that deep borings should be sunk with the express purpose of finding coal. What is wanted is a systematic survey by borings at such spots as are likely to throw light upon the structural framework of the Palæozoic floor and the thickness of its cover.

Of course, there are difficulties in the way of such a scheme. There is the expense. But in view of the enormous economic possibilities of the work, and remembering that it is now possible to sink a boring to a depth of, say, 1200 ft., and to bring up 18-in. cores at a cost less than 2000*l.*, it cannot be reasonably argued that the expense is beyond the nation's power to bear. A levy of a farthing a ton on the coal output of the United Kingdom for a single year would yield something like 300,000*l.*, a capital sum that would provide in perpetuity an additional yearly grant to the Geological Survey of 15,000*l.*, which would suffice not only to carry on this work, but would enable the Survey to extend its functions in the other directions I have indicated.

As to legal obstacles and vested mineral rights, I wish to say nothing except that if the country could be convinced that this work is urgently needed on national grounds, all scruples and doubts, so agitating to the official mind, would speedily vanish.

For many years I lived near our great exporting centres of the finest steam coal in the world, and as I watched the steady and incessant streams of coal-waggons, year in, year out, coming down from the hills, I was constantly reminded that we are rapidly draining the country of its industrial life-blood. Is it an extravagant demand to ask that an infinitesimal fraction of this irreplaceable Nature-made wealth should be set aside to provide the means for the discovery and development in our islands of new mineral fields?

Chemical and Microscopical Investigation of Coal Seams.

The recovery of by-products in the coking of coal, which up to the beginning of the war was almost exclusively undertaken by the Germans, is likely in the future to become an important British industry. This will ultimately demand a thorough knowledge of the microscopic and chemical structure of all the important coking seams in our coalfields.

Remembering how varied both in microscopical structure and chemical composition the individual laminæ of many of the thick coal-seams are, it will readily appear how important such a detailed investigation may become, having regard to the great variety of these by-products and their industrial application. Moreover, thin seams, hitherto discarded, may pay to be worked, as may also an enormous amount of small coal, estimated at from 10 to 20 per cent. of the total output, which up to the present has been wasted.

Geology of Petroleum.

It has been frequently remarked that in order to account for the vast accumulation of coal in the Carboniferous strata, it is necessary to postulate a special coincidence over great areas of the northern hemisphere of favourable conditions of plant growth, climate, sedimentation, and crustal subsidence, conditions which, although they obtained at other geological periods over relatively small areas, were never repeated on so vast a scale. Having regard to the estimates of coal deposits in Cretaceous and Tertiary strata, published in our first international Coal Census, the "Report on the Coal Resources of the World,"[1] it would appear that we might reasonably link the Cretaceo-Tertiary period with the Carboniferous in respect of these peculiar and widely prevalent coal-making conditions. For I find that of the actual and probable reserves of coal in the world, according to our present state of knowledge, about 4½ million million tons of bituminous and anthracite coal exist, the vast bulk of which is of Carboniferous age; while there are about 3 million million tons of lignites and sub-bituminous coals, mostly of Cretaceous and Tertiary age.

When we look to the geological distribution of petroleum, we note that it is to be found in rocks of practically every age in more or less quantity, but that it occurs *par excellence,* and on a great commercial scale, in rocks of two geological periods (to a smaller extent in a third); and it is significant that these two periods are the great coal-making periods in geological history—the Carboniferous and the Cretaceo-Tertiary. It would take me beyond my present purpose to explore the avenues of thought and speculation opened up by this parallel. I will only remark that it seems to afford some support for the view that coal and petroleum are genetically as well as chemically related. While the terrestrial vegetation of the two periods was accumulating under specially favourable physiographical conditions, ultimately to be mineralised into seams of coal, the stores of petroleum believed to be indigenous to strata of the same periods were probably derived from the natural distillation of the plankton which must have flourished, too, on an enormous scale in the shallow, muddy waters adjacent to this luxuriant land growth. The phytoplankton, including such families as the Diatomaceæ and Peridiniæ, may well have played the chief *rôle* in this petroleum formation, while affording unlimited sustenance to the small and lowly animal organisms, like Entomostraca, the fatty distillates of which doubtless contributed to the stores of oil. It is possible, then, that a prodigious development of a new and vigorous flora during both periods—the spore-bearing flora, in the main, of the Carboniferous, and the seed-bearing flora of the Cretaceo-Tertiary period—was the chief contributory factor in the making of the world's vast store of solid and liquid fuel. It contributed directly by supplying the vegetable matter for the coal, and indirectly by stimulating the development of a prolific plankton, from which the oil has been distilled.

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[1] Report on "The Coal Resources of the World" for the Twelfth Intern Geol. Congress, 1913.

The world's production of petroleum has trebled itself within the last fifteen years. In 1914 the United States of America produced 66·36 per cent., and North and South America together nearly three-fourths of the world's total yield; while the British Empire (including Egypt) produced only a little more than 2 per cent. In the near future Canada is likely to take its place as a great oil- and gas-producing country, for large areas in the Middle-West show promising indications of a greatly increased yield. But Mexico is undoubtedly the country of greatest potential output. Its Cretaceous and Tertiary strata along the Gulf Coastal Plain are so rich that it has been stated recently on high authority that "a dozen wells in Mexico, if opened to their full capacity, could almost double the daily output of the world."[2]

As is well known, natural supplies of petroleum are not found in the British Isles on a commercial scale; but for many years oil and other valuable products have been obtained from the destructive distillation of the Oil Shales of the Lothians. If Mr. Cunningham Craig is right in his views recently expressed,[3] these shales, or, rather, their associated freestones, have been nearer to being true petroliferous rocks than we thought; for he believes that the small yellow bodies, the so-called "spores" in the kerogen shales, are really small masses of inspissated petroleum, adsorbed from the porous and once petroliferous sandstones with which the shales are interstratified.

If recent experiments on peat fulfil the promise they undoubtedly show, we shall have to take careful stock of the peat-bogs in these islands. It is well known that peat fuel has been manufactured in Europe for many years. But my attention has been called to a process for the extraction of fuel-oil from peat which has been tried experimentally in London, and is now about to be launched on a commercial scale, utilising our own peat deposits, like those of Lanarkshire and Yorkshire.

The peat is submitted to low-temperature distillation at ordinary pressure, or at a slight negative pressure, the highest temperature reached being about 600° C. From a ton of Lanarkshire peat, after the moisture is reduced to 25 per cent., 40 gallons of crude oil, 18 to 20 lb. of ammonium sulphate, about the same quantity of paraffin wax, 30 to 33 per cent. of coke, and 5000 to 6000 cubic ft. of combustible gas are obtained. The coke is said to be of very good quality. By the same process it is hoped to get satisfactory results from the lignites of Bovey Tracey.

Considering the rapid development of oil as fuel, and its supreme industrial importance in many other ways, it is remarkable that British geologists should have given such little attention to the *origin and occurrence of petroleum*. Among American geologists a lively interest in this subject has been aroused and a voluminous technical literature is already published. And yet the fact remains that we are still in a cloud of uncertainty as to this vital question, upon the solution of which depends whether the prospector of the future is to work by hazard or on scientific and reasoned lines.

Mr. Murray Stuart, now of the Indian Geological Survey, offered in 1910[4] a simple explanation of the occurrence of petroleum, based upon his own observations in Burma, a research which seems to have attracted far more attention in America than in this country. He showed that the oil of the streams and swamps in Burma is carried down to the bottom of the water in small globules by adhering tiny particles of mud. Thus there is formed a deposit of mud containing globules of oil and saturated with water. If afterwards this deposit is covered by a bed of sand, the oil and part of the water, as the pressure of overlying sediment increases, are squeezed into the sand, so that by a repetition of the process a petroliferous series of clays and sands may be accumulated. In examining lately a large quantity of the well-known "landscape marble" from the Rhætic of Bristol, I obtained from it small but appreciable amounts of petroleum; and towards the end of my investigation I was pleased to discover that I was in thorough agreement as to the origin of this curious landscape structure with Mr. Beeby Thompson, whose research was published more than twenty years ago.[5] In these thin deposits of hydrocarbons among laminated silts, with their striking tree-like growths and hummocky surfaces, may we not have, in miniature, an illustration of the deposition and partial migration of petroleum which occurs on so vast a scale in the oilfields of the world?

It is not suggested that all petroleum deposits have had such an origin. I am convinced, however, that in all geological ages such sedimentary accumulations have occurred; and that, except where the conditions of cover have been favourable for its imprisonment, the oil is, and has been throughout geological time, incessantly escaping at the surface. Thus we may conceive the earth as continuously sweating out these stores of oil, either in the liquid or gaseous form, especially where rocks are being folded and rapidly denuded.

It is sometimes asked whether the adoption of mineral oil as a power-producer is likely to supplant coal, and thereby seriously reduce the output of that mineral. The world's yield of petroleum will doubtless go on increasing at a very great rate; but from the experience gained in some of the fields in the United States and eastern Canada, it seems unlikely that this increase can continue for a very long period. Practically complete exhaustion of the world's supply is to be looked for within 100 years, says one authority.[6] Even if the output rose to ten times the present yield, it would represent only about half the present world output of coal, and it is practically certain that so high a yield of oil could not be maintained for many years. Owing to the almost certain rapid increase in the output of coal, estimates made by the same authority indicate that the total production of petroleum could never reduce the world's output of coal by more than about 6½ per cent.[7]

For us, and probably for those of the next generation, the geology of petroleum will continue to be of immense practical importance; but coal will doubtless remain our great ultimate source of power.

An obligation rests upon us to see that the oil resources of the British Empire and of territories within our influence are explored, if possible by British geologists, with all the special knowledge that can be brought to bear; and I am glad to think that the University of Birmingham and the Imperial College of Science and Technology, London, with this end in view, are doing pioneer work in giving a systematic and specialised training to our young petroleum technologists.

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[2] Ralph Arnold, "Conservation of the Oil and Gas Resources of the Americas," *Econ. Geol.*, vol. xi., No. 3, 1916, p. 222.

[3] Institution of Petroleum Technologists, April, 1916.

[4] "Rec. Geol. Surv. India," vol. xl., 1910, pp. 320–33: "The Sedimentary Deposition of Oil."

[5] Q.J.G.S., 1894, pp. 393–410.

[6] H. S. Jevons, "British Coal Trade," 1915, p. 710.

[7] *Ibid.*, p. 716.

Organisation of Expert Knowledge.

We are reminded by the report of a Royal Commission—that on Coast Erosion in 1911—that systematic observations and the collation and organisation of geological and engineering knowledge are urgently needed in connection with the protection of our coasts and the reclamation of new lands. For it will be remembered that the Commission found that during the last thirty-five years the gain of land, as shown by Ordnance Survey maps, has been more than seven times the loss by erosion.

Here, again, the British Association may reflect with pride that it paved the way for this national inquiry. For many years its Committee on Coast Erosion gathered and collated evidence on erosion, and induced the Admiralty to instruct the coastguard to observe and report upon changes that take place from time to time.

After recommending "that the Board of Trade should be constituted the Central Sea-Defence Authority for the United Kingdom for the purpose of the administration of the coast-line in the interest of sea defence," the Commissioners go on to urge that "that Department should have the assistance of scientific experts to collate information and to secure systematic observations with regard to questions such as the changes taking place below the level of low water, the travel of materials in deep water, the movements of outlying sandbanks, etc., which are continually happening on the coasts of the kingdom, and with regard to which the information at present is scanty and vague."[8]

In economic geology, as in the case of other applied sciences, we must rely in the future less upon chance individual effort and initiative. We must concentrate, centralise, and organise; and at every stage we shall need expert control and advice as regards those larger scientific issues of national importance which have a direct practical bearing.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Leeds.—The annual report of the Department of Coal, Gas, and Fuel Industries, of which Prof. J. W. Cobb occupies the chair as Livesey professor, has just been issued by the University. It begins with a reference to the number of students who have entered the Army or are connected with the war work of the department, and also to the election of candidates to the recently founded Corbet-Woodall scholarship and Arthur Walker exhibition. Courses of lectures, which have been given in the past by specialists connected with the gas and fuel industries, have had to be restricted owing to the demands made by the war upon the lecturers. The research work of the department during the year includes two important publications. The Ventilation Research Committee, representing the Institution of Gas Engineers, has issued its third report. The work has been carried out, as before, by Mr. W. Harrison, who has made a careful and interesting study of causes of down-draughts, the effect of ventilating burners, etc. The second research, by Prof. Cobb and Mr. H. Hollings, on "Thermal Phenomena in Carbonisation," was read before the Institution of Gas Engineers in June last. The other work of the department has been mainly on behalf of the Ministry of Munitions and the Royal Society War Committee.

The chemical courses of the Finsbury Technical College, which commenced on Tuesday, October 3, are undergoing modification and extension in order to cope with the increased demand for chemists trained to take up industrial posts. Commencing at first with a two-year curriculum, the courses have in recent years been extended over a period of three years, and in many instances students have, with profit to themselves, continued their advanced studies into a fourth year and even longer. If the renascence of British chemical industry is to be fruitful, there will not only be a demand for more chemists, but it will be essential that these newcomers should be better trained than their predecessors. The Executive Committee of the City and Guilds of London Institute has placed at the disposal of the chemical department of the Finsbury college a new suite of rooms, to be fitted as advanced laboratories of applied chemistry. The work of adaptation is in full progress, and the laboratories will be sufficiently ready for advanced students early in the new year. The installation of technical appliances is being extended, partly by purchase and partly by construction in the chemical department. Factory methods of conducting filtration, evaporation, distillation, desiccation, heating under pressure, and other generalised processes will be studied, and the possession of this plant and apparatus will render possible the execution of industrial researches in many branches of inorganic and organic chemistry, as, for example, the extraction of metals, preparation of alloys, cements, glazes, porcelains, glass, enamels, pigments, synthetic dyes, artificial perfumes, and pharmaceutical products. One gratifying feature of this development is the fact that the effort to develop along industrial lines is so far appreciated by certain firms that they have assisted by gifts of plant and chemicals.

In a pamphlet of thirty-six pages, entitled "Scientific Method in Schools" (Cambridge University Press, price 1*s.*) Mr. W. H. S. Jones, senior classical master at the Perse School, has put forward some well-timed suggestions upon a subject now universally admitted to be of first-rate importance. Starting from the assumptions (1) that all subjects, in different ways and to different degrees, can be made to give a training in scientific method, and (2) that the scientific training even of the future researcher in physics or chemistry will be more effective if it is not confined to his special subject, but rests on a broad foundation, he puts forward the thesis that "whatever subjects are included in the curriculum, each one should contribute its quota to a comprehensive scheme of scientific method." He does not demand a strict "heuristic" treatment of every subject, but maintains that in lessons occurring regularly "once a week or once a fortnight in each subject," the pupil should be confronted with problems to be attacked by strict application of the methods of deduction and induction—particularly the latter—and should be taught to be constantly conscious of the necessity of working according to fixed laws. Mr. Jones introduces his proposals by quotations from Cicero and Charles Lamb, but does not show whether he is aware how entirely they are congruent with the results of the best relevant psychological researches of the present day. Be that as it may, the practical teacher will be more directly interested in the eleven detailed examples, drawn from courses in languages, history, geography, biology, and mechanics, which the author gives in illustration of his thesis. Of these, some represent the joint work of master and class, some the unaided work of schoolboys or undergraduates. It would be unreasonable to expect them to be proof against criticism (indeed, Mr. Jones disclaims any intention of offering them as models), but all will be found interesting and instructive as exemplifying a method of procedure of the general soundness and importance of which there can be no doubt.

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[8] Royal Commission on Coast Erosion, etc., 1911. Third (and Final Report, pp. 160–61.